CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

SECRET/CONTROL U.S. OFFICIALS ONLY

[redacted]

25X1

COUNTRY	USSR (Moscow Oblast)/Germany	REPORT	
SUBJECT	Missile Development at KB-3, [illegible] Krasnoarmeysk, and Preliminary Work in Germany	DATE DISTR.	10 June 1954
		NO. OF PAGES	22
DATE OF INFO.		REQUIREMENT NO.	RD
PLACE ACQUIRED		REFERENCES	

25X1

25X1

This is UNEVALUATED Information

THE SOURCE EVALUATIONS IN THIS REPORT ARE DEFINITIVE.
THE APPRAISAL OF CONTENT IS TENTATIVE.
(FOR KEY SEE REVERSE)

25X1

1. The German engineers at Putilovo were divided into three labor groups, each of which had its special task to fulfill.

25X1

2. The villages of Putilovo, Fabrika Kraft, and Krasnyy Poselok, the firing range, and KB-3 are included under the collective name Krasnoarmeysk. (See sketch on page 20). Krasnoarmeysk (N 56-06, E 38-07) is located approximately 70 kilometers northeast of Moscow and is reached by a small branch line, which leads approximately 15 kilometers eastward from the Moscow-Yaroslavl (N 57-35, E 39-50) railroad between the stations of Pushkino (N 56-01, E 37-51) and Zagorsk (N 56-19, E 38-03) at the station of Sofrino (N 56-08, E 37-54). The terrain around Krasnoarmeysk is wooded, but the woods in the western section near the tiny Vorya River, which flows in a general north-south direction, have been cut. Distinguishing features of the area are the 30-meter-high water tower, the practice ranges, the churches in the villages of Putilovo and Murmanskoye, and the old factory building in the village of Fabrika Kraft.

25 YEAR RE-REVIEW

SECRET/CONTROL U.S. OFFICIALS ONLY

STATE	x	ARMY Ev	x	NAVY Ev	x	AIR Ev	#x	FBI		AEC		ATIC Ev	x	OSI Ev	x

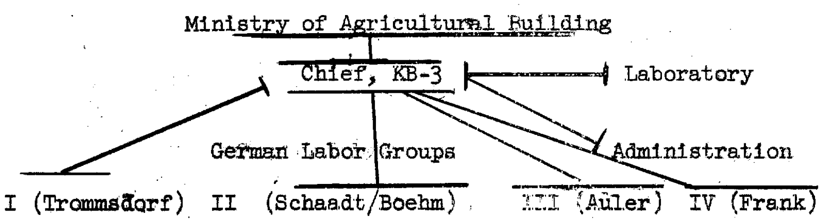
(Note: Washington Distribution Indicated By "X"; Field Distribution By "#".)

3. The total installations gave the impression that they had all existed even before the war. In 1946, the installations were under brisk construction. In recent years no further expansion work had been undertaken. Essentially Krasnoarmeysk was divided into the Design Bureau and the firing range. Both divisions were completely independent organically and had nothing to do with one another.

Organization of KB-3

4. The Design Bureau bears the designation KB-3. It is subordinate to the Ministry of Agricultural Machine Building. [redacted] this is obviously a screen. No clue as to the actual directing office or ministry was ever established, however. 25X1

5. The structure and organization of KB-3 were as follows:



6. Local Soviet control was exercised by the Soviet Davyshev (fnu) [redacted] His assistant was Ulyanov (fnu), an engineer, civilian, [redacted] 25X1

7. The German labor groups comprised, in all, 16 engineers, who had been deported to the USSR at the same time and also released together on 16 May 1952. After that no more German personnel remained in KB-3. Until June 1947, they worked essentially without Soviet co-workers except for auxiliary personnel. Sometime in June 1947, 50 Soviet engineers were attached to them. Each labor group in that period comprised, in all, about 30 engineers, draftsmen, and helpers.

8. At first, the work was performed jointly between the Soviet and German engineers. From 1948-49 on, the previously homogeneous work was gradually divided and in 1950 a complete separation of the groups into Germans and Soviets took place. It could no longer be observed what the counterpart Soviet groups were doing. German knowledge was progressively taken over by the Soviets, while the latter, for their part, offered no insight into further development and were very mistrustful. The total number of employees of KB-3 amounted to approximately 400 men, 200 to 250 of whom worked in the laboratory.

9. The German Labor Groups consisted of the following:

Labor Group I - Supersonic ram-jet missiles (Tr. Geschosse)

Labor Group II - Panzerfaeuste

Labor Group III - Powder rockets

Labor Group IV - Powder group

10. Labor Group IV was soon dissolved and the personnel were rotated among the other groups. In this group were the following:

Dr. Eugen Saigger, director - former chemist at the WASAG.

Arthur Frank, engineer - a detonator construction expert from Soemmerda.

Dr. Hans Rakett - former chemist at the WASAG.

Hugo Peukert, engineer.

H. Heide (fnu), engineer - later with Auler, [redacted] 25X1

11. Soviet co-workers with Labor Group I were the following:

Lieutenant Colonel Sudakov, wore civilian attire.

Engineer Metrikhas, [redacted] 25X1

Engineers Rotshteyn and Fridman, MVD functionaries assigned as observers.

12. German Labor Group II was directed by Graduate Engineer Franz Schaadt, formerly of HASAG in Dresden, specializing in the construction of the Panzerfaust. Other members of this group were the following:

Fritz Boehm, engineer from Berlin, who later took over leadership of the group [redacted] 25X1

Timmler (fnu), engineer from Leipzig.

Dr. Rudolf Oswald, engineer, formerly of Budin (N 50-25, E 14-09).

[redacted] the Soviet co-workers [redacted] group developed Panzerfausts. Its tasks were the improvement of manufacture and increase of range. The stages of development exceeded 15, 30, 50, 100, and up to 150 meters. [redacted] results of this work as follows: up to a range of 150 meters the target was reached with an accuracy of 1.5 x 1.5 meters. Yet the Soviets demanded ranges of 300, 400, 500, and 600 meters with an accuracy of 4.5 times 4.5 meters. These requirements could not be fulfilled, causing the group a good many troubles. 25X1 25X1

13. German Labor Group III (Auler) consisted of the following:

Herbert Karl Auler, engineer, formerly plant manager of the Marienfelde factory, expert in the field of powder rockets of every type.

Belonging to the Auler group were the following:

Hugo Paul Taubert, mathematician.

Dr. Karl Lauch, physicist.

Hans Bachmann, graduate mathematician, ballistics expert.

Heinz Bauschke, graduate engineer, rocket chamber designer.

Wilhelm Eisenkrämer, engineer.

[redacted] 25X1

Sanitized Copy Approved for Release 2010/01/19 : CIA-RDP80-00810A003900600005-8

14. The group was engaged in the development of powder rockets for the following:

a. Air-ground tank combat.

b. Tank combat by means of mother rockets which eject five daughter rockets.

c. Air-ground combat.

d. Antiaircraft artillery.

[redacted] individual projectiles had been tested with success. [redacted] in disputes with the Soviets the operation of the missiles was under controversy, but [redacted] less because of poor performance than because the Soviets wished to cause annoyance. [redacted] they were reasonable designs and produced good results. The operations of the group were suspended in 1950. [redacted] In addition, the group was engaged in the development of a two-centimeter cannon which was to attain a cyclic rate of 30,000 rounds per minute. Through special techniques a very high cyclic rate of 16-24 rounds at a time was actually reached, which by mathematical extrapolation would amount to 30,000 rounds, were it not necessary to reload after the 24th round. 25X1 25X1 25X1 25X1

. The Firing Range

15. The firing range was a separate unit and had its own commanding officer, who was always an air force colonel. In 1946, the commanding officer was Colonel Ivanov. In 1950 he was succeeded by another air force colonel, [redacted] The firing range served the following purposes: 25X1

a. The firing of light antiaircraft weapons, antitank and field guns, and howitzers with calibers up to 150 mm.

b. Discharging of light and medium caliber powder rockets up to 28 cm.

c. Occasional dropping of bombs, flash bombs, and flares.

d. Bombings in fall 1951 by a modern bomber with two TL (Turbinenluftstrahlmotor -- turbojet engines).

Occasionally noises from the firing range lasting up to 60 seconds could be heard, which suggested the operation of a V-1 propulsion unit. Present at the practice ranges were the simplest V_o (sic) measuring instruments, captured German apparatus, and gas measuring devices. These were, in general, obsolete and impracticable. Officers of all branches of the services arrived daily from Moscow at the firing range. [redacted] 25X1

. The Wind Tunnel

16. [redacted] direct access to the 10 by 10 centimeter high-pressure wind tunnel [redacted] The existence of a larger wind tunnel was kept secret by the Soviets. [redacted] the 25-cm wind tunnel was built on the basis of [redacted] This construction started in the middle of 1950. At the time [redacted] the bare brickwork construction was completed. 25X1 25X1

17. The nearest airfield is located 1000 meters west of the Moscow-Yaroslovl railroad line, between Moscow and the railroad station of Post 81 Km.

25X1

Page Denied

Next 1 Page(s) In Document Denied

 [redacted] 25X1

[redacted]

25X1

Activities in KB-3

28. The second period of work [redacted] began in the KB-3 at Krasnoarmeysk. Twice in November 1946 and once in March 1947 the Minister paid a personal visit. In March 1947 he declared, "We consider the work on the ram-jet engine an especially important and promising development." The tasks in the second period of work consisted in the following: 25X1

a. Completion of the report on "the theory and operation of the ram-jet power plant at high Mach numbers", with the following sub-headings:

1) The auxiliary thrust supersonic diffusor.

2) The auxiliary thrust supersonic diffusor with variable collector.

3) The fuels of the ram-jet engines.

4) Technical problems in the manufacture of ram-jet engines for high Mach numbers.

5) The possibilities of bringing ram-jet engines to the required high initial velocities. The various types of ram-jet engines for high Mach numbers.

b. Demonstration of the principle of the ram-jet engine at high Mach numbers with projectiles of the E-Series, including the E-5, E-6, and E-7 experimental missiles of 15 cm caliber and without explosive charge.

c. Completion of the C-3, a 28 cm shell for the German K-5 railroad gun.

d. Design, construction, and operation of a 10 by 10 cm high-pressure supersonic wind tunnel for ram-jet engines.

Added later to these tasks were the following:

e. Development of the A-4 (to be capable of carrying 250 kilograms of explosive for 150 kilometers).

f. Design and construction of a 28 by 28 cm high-pressure supersonic wind tunnel.

29. On the basis of the development and fulfillment of the above tasks through the instructions, work directives, and fulfillment wishes of the Soviets, [redacted] conclusions could 25X1
be drawn concerning the concepts prevailing under the management of the Soviets, despite the fact that the latter exerted every effort to disguise their own ideas and their real intentions. The following impressions were gained or facts established:

a. At no time was the center of development located in Putilovo. Evidence was clear that an agency [redacted] was repeating all operations and designs to the minutest detail and conducting all tests all over again under controlled conditions. 25X1 Through exhaustive and ever-recurring inquiries, possible only on the basis of carefully conducted parallel work, it became evident that the Soviets with large resources and skilled manpower were checking every train of thought and every proposal by means of actual testing.

b. The development of ram jet-engines is being taken very seriously in the Soviet Union and is considered promising.

c. The discovery of principles was given broad attention. Some 40 different individuals in all, for the most part with a good education in gas dynamics, thermodynamics, and engineering in general, [redacted] Among them were detached 25X1
officers of all three branches of the armed services, dressed in civilian attire, and members of the Moscow and Leningrad Universities.

d. In 1949, at the latest, the thermodynamics and gas dynamics concepts [redacted] had been recorded in the appropriate textbooks. [redacted] 25X1

e. Up to 1949 approximately 200 missiles of the experimental series were successfully fired at the Putilovo firing range. Accelerations of 950 meters per second and initial velocities of up to 1460 meters per second maximum at an engine efficiency of up to 40 percent were recorded. [redacted] 25X1

f. The firing of the C-3 projectile to distances of up to 350 kilometers turned out successfully in the winter of 1949/50. The further development and application of this projectile is concentrated in the Navy. The following are expected:

1) That shells of this type, of 21 cm caliber and up, will be able to provide surprisingly long-range fire from the sea to coastal area targets.

2) That, in ship-to-ship combat, shells of this type, from 21 cm caliber and up, will be able, as a result of their striking velocity of 1500 to 1800 meters per second, to develop great armor-piercing capacity and, as a result of the flat trajectory (average flight speed, 1500 meters per second), to cover a greater zone in depth.

3) That the shorter flying time will make possible faster trial fire.

30. The other more significant point of development lies in the very cheap mass production of ram-jet powered missiles with powder rocket launching such as A-4s, which can effectively convey explosive charges of 250 kilograms and heavier to area targets through medium to great distances. As a result of some very revealing observations of the engineer Metrikhas, it is possible that atomic explosives are even being contemplated.

31. The 10 by 10 cm high-pressure supersonic wind tunnel in Putilovo has been available as a research facility since 1949. In the tunnel, Mach numbers of up to 3.2 are attainable, while magnitudes within the tunnel measuring range amount to one kilogram per cm^2 and 18°C during a blast period of 12 seconds. At lesser magnitudes the Mach number is eight.

32. In spring 1953, at the latest, the 28 by 28 cm tunnel in Putilovo will be available. The Mach numbers and magnitudes are the same as with the 10 by 10 cm tunnel. [redacted] 25X1

33. [redacted] further details in regard to the C-3 projectile, as follows:

a. The C-3 was already finished by the end of 1949. [redacted] 25X1

b. [redacted] the A-4, a powder rocket fired from a rocket launching rail, and the C-3, fired from 28-cm railroad guns, have been, or will be, rendered capable of effective use by the Soviets at ranges of 150 and 350 kilometers. The K-5 railroad gun has a normal range of 53 kilometers. 25X1

c. [redacted]

d.

25X1

Prospects and Program for the Future Development of Ram-Jet Engines

34. The future development of the ram-jet powered missile must be based upon the present situation. That may be described briefly. The principle of jet powered missiles may be presumed to be common knowledge, [redacted]

25X1

Missiles in the A-series

35. Large shell bodies with auxiliary thrust diffusor, large central combustion chamber, and stabilizing surfaces (flying without spinning), remote controlled on ocassion, by means of a powder rocket, attain the necessary initial velocity of approximately Mach 1.5. In the first stage of flight the combination shell-powder-rocket is guided along a firing track. This firing track sets the initial direction of the flight path. After the powder rocket or powder rocket composition has burned out, the rocket is expelled and the ram-jet power action begins. This functions until the fuel is exhausted, at an altitude of approximately 25 kilometers, and then the missile travels freely along a ballistic curve.

36. Present projects in the A-series are as follows:

Project	Kilograms	Kilometers	
A-1	50	50	Drafting project only.
A-2	50	150	Drafting project only.
A-3	250	50	Drafting project only.
A-4	250	150	Executed and attained.
A-5	250	300	Drafting project only.
A-6	1000	300	Drafting project only.

Of these designs the A-4 is test-proven. A distance of 150 kilometers and a pay load of 250 kilograms have been realized. Additional types of the

A-series, A-5 and A-6, promised a stepwise increase of range and pay load up to 300 kilometers and 1000 kilograms.

37. The powered missiles of the A-series are produced as simply and cheaply as possible. The primary part of the missile (see Enclosure 1, sketch of A-4) is a standard thin-walled tube. The central body is welded together from simple sheets. Fine mechanical treatment is reduced to a minimum. The fuel required amounts to between six percent and ten percent of the missile by weight. The A-series missiles can carry a pay load up to 20 percent of the total weight. A caliber between 30 and 80 cm and a missile length of between 2.50 meters and 10 meters seem most practicable. The firing from a rail, which is mounted as a revolving unit on a truck or a full-track vehicle, allows a firing position at a good vantage point, well camouflaged, and independent of roads and railroads. The take-off by powder rocket produces great sources of error in the flight path. The deviation through installation of a remote-control mechanism (radar-control) would rob this model of its most important advantage, its low cost of production. Future developments would have to be along the following lines:

a. Maintaining the over-land mobility and inconspicuousness of the firing unit.

b. Maintaining the simple, cheap construction of the missile body.

c. Careful examination of the possibilities of improving the deviation.

38. The most serious disadvantage of the entire type is the necessity for powder take-off. The total weight of the powder take-off rocket is approximately equal to the weight of the ram-jet missile. Emphasis in the further development must be put on increasing the range of velocity in which the ram-jet motor can operate, thus increasing the initial velocity required by the ram-jet motor, and consequently permitting the mass and weight of the powder take-off rocket to be lowered. For this purpose there are arrangements which promise success. Careful study has shown the possibility of developing combinations of Schmidt-tubes and ram-jet engines in such a way that these combinations operate as Schmidt-tube in the lower velocities; the frequency of the individual combustions of the Schmidt-tube increases as the velocity increases until about Mach number 1.5, when the combustion goes over into the continuous type of the ram-jet engine. [redacted] 25X1 The initial velocity which would be effective in such a combination is estimated at about 80 meters per second, a velocity which can be delivered by a standard catapult or a very small powder rocket. The first experimental results on such combinations of Schmidt-tube and ram-jet motors might occur early in 1954.

Missiles in the B-Series

39. In the case of missiles and launching units of the B-series the guiding principle was as follows: The increase of initial velocities of projectiles in standard guns reaches a limit, according to caliber, in the neighborhood of 900-1000 meters per second. If higher velocities are to be obtained, there is a necessary disproportionate expenditure on the gun (gun weight, weight of powder charge, erosion within the rifle, shortening of the life span), which makes the increase of projectile velocity beyond the limit stated economically impracticable or, indeed, impossible. If greater initial velocities and longer ranges are necessary, it is obvious that a basic velocity (600-900 meters per second) should be fixed for the gun itself, and then the projectile should be developed as a ram-jet engine, which increases its own velocity after leaving the gun. The fact that this mechanism has become possible in both principle and in practice by means of the yet-to-be-discussed C- and E-series is shown by the following. If one intends to fire a missile out of an ordinary gun, such requirements will

be set for the construction of the missile itself (through the discharge process, resistance against discharge acceleration and against gas pressure within the bore) as to require anything but the desired form for a ram-jet engine; indeed, these considerations would make the missile heavy and clumsy and totally unsatisfactory as a ram-jet engine. If one no longer proceeds on the basis of internal ballistics for the gun on hand, but rather considers the firing aperture and the ram-jet missile as an indivisible unit, then it is obvious that not only the form of the missile must be altered but that various changes in the form of the gun can and must be made. For 400 years the development in guns has been toward the highest possible cross-section load on the diameter of bore with high initial velocities (extended rifle length, ovicular form of the projectile, high gas pressure). This development was necessary in order to give the projectile a greater range, for only the projectile with high mass per unit of diameter of bore is able to overcome greater trajectories without too great a velocity drop through friction. This necessity of combining the smallest diameter of bore with the greatest possible mass no longer applies in the case of the ram-jet missile (Tr-Geschossen). The thrust of the ram-jet engine can be considered as a counter to negative air pressure. If one strives for a high velocity of this ram-jet missile during its powered flight, one must, in contrast to the historical development of projectiles, keep the cross-section load, mass per unit of diameter of bore, as small as possible; thus, small weight with large caliber is desired. When high cross-section load is no longer necessary, the gun can be constructed quite differently and the internal ballistics can be designed for much lower gas pressures. Such firing devices are to be developed from mortar units. Gas pressures between 500 and 200 kg/cm^2, in certain cases long rifle length without recoil mechanism, will suffice since firing is done only in the upper firing angles. The advantages over the conventional gun would be, with the same muzzle energy, a decrease in firing unit weight down to a third or a fourth, and considerable extension of the life expectancy of the rifle. The advantage in favor of the powered missile is easier design as a result of dropping the requirements for high gas pressures and initial velocity. An advantage over the A-series is the fact that initial velocity and initial direction can be much more accurately controlled than with the uncertain launching by means of the powder rocket. The projectile and the extremely long launching device of the A-series have not yet been built; they have merely been designed.

Evaluation of the Prospects of the B-Series

40. The B-series seems [redacted] to be the most promising of all projects on the development of projectiles and missiles for long ranges (100-400 kilometers) and heavy pay loads (150-1000 kilograms). In combination with simple acceleration-control devices, a sufficiently small deviation can be guaranteed even over great distances without any complicated remote-control mechanisms, since the long launching tube permits a sufficiently accurate supply of initial data for the ballistic curve. The price of the missile might be brought to an absolute minimum. Pay loads of 20 percent to 30 percent of the total weight and a service load of fuel below 10 per cent of the total weight seem possible. The only disadvantage is the relatively large dimensions and conspicuousness of the launching device. Although the long launching device can be dismantled into sections small enough to be handled for transport, reassembly and installation require several hours and could scarcely be concealed from a vigilant enemy air reconnaissance. This is also the reason why the Soviets showed little interest in the development of this series. They assumed that such conspicuous units could not long avoid detection in case of enemy air superiority, which they always take for granted. The further development of this promising B-series would have to consider as aims: 25X1

a. A lowering of the necessary initial velocity.

b. An extensive simplification of the launching device in order to decrease the time necessary for assembling.

41. [redacted] the designing of a missile with the following characteristics for testing the principles of the B-series: 25X1

Pay load-250 kilograms.

Range-150 kilometers.

Diameter of bore-57 cm.

Length of the launching tube-36 meters (capable of being dismounted into six equal sections, each six meters long).

Launching tube attached to launching base plate without recoil mechanism.

Initial velocity-800 meters per second.

Highest gas pressure-500 kilograms/cm^2.

Weight of launching tube-30 tons.

Weight of base plate-8 tons.

Such a missile (to be designated B-3 in the development series) might combine optimal mobility with good range, low deflection, and the lowest production cost. The use of a propellant other than chemical explosives is easily possible. For the explosive, whatever type it might be, a space of 0.16 to 0.2 m^3 is provided.

C-Series

42. [redacted] projectiles which are fired from standard guns. During the firing process with the gun, a cartridge-case base covers the hollow chamber running through the entire projectile, in which the propelling forces of the ram-jet are later released. This cartridge-case base falls off after the projectile has left the muzzle of the gun. The projectile is stabilized through rifling. The ram-jet begins to operate immediately after the projectile leaves the gun muzzle. The initial velocity is set for more than 900 meters per second. At this velocity and with suitable fuels, self-ignition of the fuel is guaranteed. The fuel is driven partly by rotation and partly by means of special aids (pressure gas, burning powder cartridge) through jets into the combustion chamber. The most important results of the development projects were: 25X1

a. The design of the diffuser at the nose of the missile in such a way that the projectile operates under almost optimal conditions in a rather great velocity interval (Mach = 2.6 to 6).

b. Design of the projectile so simple as to place the cost of production no higher essentially than that of the standard projectile for the same gun. This goal was reached to the extent that the production-material costs for missiles of the C-series were only 2.0 to 2.2 times as high as the costs for a regular projectile.

c. Development of a simple control devices for limiting the dispersion of range on a horizontal target:

   1) The introduction of a simple acceleration regulator (in testing stage).

   2) The introduction of a means of limiting the combustion period (not yet being tested).

d. Limitations. Exhaustive investigations have shown that projectiles of the C-series are not to be built under 21 cm caliber. Twenty-one centimeters is the limit below which an explosive pay load can not be borne. The larger the caliber, the larger the borne explosive pay load can be in proportion to the normal fuel load. In 38-cm caliber missiles already 65 percent of the explosive pay load of the standard projectile can be carried. The initial velocity cannot be reduced essentially below 900 meters per second. The maximum velocity is about 1900 meters per second. The heating-up at this velocity causes serious difficulties.

e. Ranges up to 360 kilometers can be realized. Within these limitations the powered missile of the C-series is, for all calibers above 28 cm, an effective and promising improvement on existing missile types. These missiles can be used at very low cost. The gun tube is not subject to the stresses occasioned by ordinary projectiles. The gas pressure is always around two-thirds of normal gas pressure. Only through the use of the cheap powered missile of the C-series can ranges up to 350 kilometers be reached with any gun, from 28 cm caliber on up.

D-Series

43. In the D-series, missiles are planned which no longer fly on a ballistic curve but by remote control in horizontal flight at great altitudes over maximum distances. The take-off here, too, affords difficulties which have not yet been ironed out. A take-off by means of powder rocket requires enormous velocity for such a missile. The total take-off unit of powder rockets would weigh two to three times as much as the missile itself. Another launching method seems more promising. A heavy mother aircraft tows the missile to 12,000 -15,000 meters' altitude. The missile is then released in a dive and brought up to Mach number 1.5 by means of a small powder rocket. Mach 4 has been determined as the most favorable operations Mach number for missiles of the D-series. From Mach 1.5 up to Mach 4 the missile propels itself by using its own fuel supply, which likewise produces the energy necessary to lift the missile to its most favorable operational altitude (24 kilometers). A ten-ton missile flying 1200 meters per second at 24 kilometers' altitude uses 1.5 kilograms of fuel per second. With its fuel supply of 6000 kilograms it can fly 4000 seconds and can cover a powered-flight distance of 4800 kilometers . It can cover an additional distance of about 400 kilometers in glide flight; thus, distances of over 5000 kilometers can be attained with such missiles. Operational velocities greater than Mach 4 appear to be unfavorable for the following reasons:

a. The efficiency of the ram-jet engine does not increase essentially with increased Mach number.

b. The fuel requirement for each kilometer of distance increases.

c. The heating-up of the entire missile at higher Mach numbers would require the use of expensive special alloys in the construction.

d. The thermal stress of the combustion chamber cannot be endured over extended flight periods by alloys known at this time. In the case of the above-mentioned example, all parts of the missile are exposed to temperatures of about 620°C. The combustion temperature will amount to about 1100°C.

Experimental E-Series

44. In the E-series (E-1 to E-7 produced and tested) were powered missiles which were shot from guns of 10.5 cm (E-1), 12.2 cm (E-2), and 15 cm (E-3 to E-7) at a small quadrant angle of departure (six degrees). These missiles carried no pay load and were used merely to test the propulsion

 [redacted] 25X1

process in free flight. [redacted] This E-series produced cheaply and conclusively a large fund of knowledge. A missile of the E-series cost about 200 to 250 RM and produced data for the construction of larger missiles.

F-Series

45 F-1 and F-2 in the F-series are antiaircraft missiles which have been designed and constructed in detail (1945). Present-day flight velocities and altitudes make it inadvisable to pursue these types further.

Summary

46. According to the preceding discussion the following projects offer promise of success:

a. A reconstruction of A-4 and, on the basis of the knowledge to be gained through this reconstruction, the continued development of missiles and powder rockets for distances of 100 to 350 kilometers and pay loads of 250 to 1000 kilograms. The chief emphasis in the development program will be placed on the effort to reduce the initial velocity of the ram-jet engine through combination with the Schmidt-tube.

b. Construction of the B-3. A carefully prepared drawing model of B-3 can be produced within four months after assignment of contract. Experiences with a B-3 unit could help in producing data for the further development of types in this series, which could be developed as long-range artillery and mounted on ships for use in naval warfare.

c. A reconstruction of the C-3 or similar missiles of the C-series for guns of 28 cm caliber and up. Most promising utilization of this type is on shipboard for naval warfare. A carefully worked out construction of this type can be prepared within six months after assignment of contract.

d. Missiles of the D-series for maximum distances of 5000-6000 kilometers. Pay loads of 1000 kilograms can be established as standard. The scarcely promising powder-rocket launching of the missiles of the D-series is not recommended. A missile of the D-series can be designed and constructed when the data for a launching from a heavy mother aircraft has been clarified. Then the construction of a D-series missile will meet with no significant difficulties as far as the problem of propulsion is concerned. The question remains unanswered, whether an effective control by means of radio control units can be realized over such great distances. The construction and careful completion of the driving mechanism of the D-missile might require four months.

e. If the further development of ram-jet engines for high Mach numbers is seriously considered, the continuation of the experiments with the simple E-types promises good results. The most suitable caliber seems to be 15 cm, [redacted] The completion of a missile design for the E-series requires about three months. 25X1

47. Characteristics of the powered missile, C-3:

a. Launching unit: German railroad gun K-5 (230 tons).

b. Initial velocity: 1225 m/s.

c. Gas pressure: 1680 kg/cm^2.

d. Missile weight at take-off: about 175 kilograms.

e. Maximum velocity: 1860 meters per second (at an altitude of 29 kilometers).

f. Missile weight after burning: 155 kilograms.

g. Efficiency of combustion: 47 percent.

h. Fuel: 16.3 kilograms of a mixture of flame-thrower fuel and carbon disulphide.

i. Range: 350 kilometers.

j. Range dispersion on horizontal target: 5 to 8 kilometers.

48. Description of the powered C-3 missile and its function (see Enclosure 4; numerals in the text below refer to corresponding points on the sketch):

a. Preparation for firing:

The missile, less diffusor spike (1), nose (5), striker (6), detonator (8), and cartridge-case base (34, 43), is taken from the packing case and installed in a rack (<u>Laboriervorrichtung</u>) in such a way that it can easily be rotated around its gravitational axis, so that now the nose and then the tail of the missile can point vertically upward. The nose of the missile is swung upward. The igniting charge (9,10) is inserted, the detonator is threaded on (8), the striker (6) and the nose (5) are inserted. (The very sensitive nose piece and diffusor spike are protected in transport by cotton-wadding packing.) The tail of the missile is swung upward. In a filling can the flame-thrower fuel and carbon disulphide are weighed off and mixed. The mixture is then poured into the fuel container (31); the packing ring (42) is carefully threaded in. This causes a drop of excess fuel to run out at the opening (40). Then the venting screw (40) is inserted and screwed tight. Finally the cartridge-case base (43, 44) is inserted. This must sit loosely and slide easily. If a cartridge-case base sticks, it should be discarded. The seat and sliding surfaces of the cartridge-case base are to be cautiously cleaned and slightly greased before being inserted. After the cartridge-case base has been inserted, liquid paraffin (1.5 kilograms) is poured in at the funnel of the jet (3). The paraffin, when cooled, holds the cartridge-case base firmly in position and is pressed, at firing, by the powder gas pressure into the fine crevice between the missile and the cartridge-case base, thus preventing the cartridge-case base from seizing or sticking or being blocked by the residue of combustion. The so-prepared missile is placed into the gun-barrel combustion chamber in the usual way, during which operation special care is taken to see that the sensitive diffusor spike is neither bent nor otherwise damaged nor the missile nose damaged.

b. Firing (launching)

Barrel length of the K-5: 20 meters.

Maximal gas pressure in firing the heavy (174 kilograms) powered missile C-3 provided with paraffin: 1660 kg/cm^2.

Terminal twist: 5 degrees 42 minutes.

Initial velocity: 1225 m/s (Mach 3.6).

In launching, rotation and initial velocity are imparted to the missile in the extended portion of the gun barrel by the pressure of the powder gases. The cartridge-case base prevents powder gases from entering the combustion chamber of the missile between the casing and fuel container (23).

The rotation flaps (15) cause the liquid fuel to rotate along with the missile before the latter has left the gun barrel. That portion of rotating liquid between the rotation flaps is driven outward by centrifugal force and leaves the area between the rotation flaps at the outer wall of the fuel container. There is still no rotational flow of liquid along the axis. After a few turns of the missile the entire contents of the fuel container are driven by the rotation flaps and are involved in the rotation of the missile. The propellant (32) is likewise ignited within the gun barrel. Under the effect of the discharge acceleration of 6000 g (sic) the firing pin (36), as a result of its inertia, breaks the shear pin (37) and strikes against the ignition cap (30). Through the pointed flame of the exploding ignition cap (30) the primer charge (35) is ignited. After a very small pause, the primer charge (35) conveys the flash on to the powerful ignition charge (33), which in turn ignites the (carefully cleaned and roughened) surface of the propellant (32). The rising powder gas pressure in the chamber of the fuse cap (38) bursts and opens the weakened central part of the fuse cap in such a way as to permit the powder gases to enter the fuel container (23) and exert a pressure on the fuel. The cylindrical propellant (32) is wrapped by a chemical-mechanical process with a propellant cover (alternating layers of asphalt and elastic crepe paper applied under pressure) in such a way as to allow only the frontal area to burn. A safety pressure valve, not drawn in sketch, allows the escape of excess gases so that the powder gas pressure will not rise over a desired maximal level.

c. After firing (launching)

After the discharge, air pressure has been built up in the combustion space between the outer shell (2) and the fuel container. This pressure ejects the cartridge-case base from the missile. Through the compressed hot air the collodion layer (45) is likewise destroyed and the spray nozzles (24) are cleared. The fuel, under a powder-gas pressure of approximately 180 atmospheres and under an additional centrifugal force of about 38 atmospheres in the peripheral area of the fuel container, is led through the fuel lines (16) to the acceleration regulator (19, 20, 21, 22, 46, 47, 48, 49, 50). The acceleration-regulating weight (20), with interval rings (47, 48), slides freely over the light elastic split tube (21) made of plastic. The acceleration-regulating weight is held between two leaf springs (19). If the driving thrust makes the longitudinal acceleration too high, the acceleration-regulating weight, under the influence of the acceleration, slides to the rear, covering over the passage slit and throttling the fuel supply. If the acceleration is too low, the acceleration-regulating weight opens up a greater portion of the slit in the split tube and the fuel supply increases. Through the fuel lines (17) the fuel is led out of the split tube into a circular distributor space before the spray nozzles. A thorough preparation of the fuel-air mixture is provided by the 480 spray nozzles (24), whose inside diameter is 0,25 mm. The spray nozzles are inserted in deep cavities, the ignition cavities, in such a way that the ignition cavity supports the ignition process as a type of "flame holder". At the same time the vortex area at the edge of separation of flow at the end of the explosive container (11) has a stabilizing effect on the formation of the flame.

Upon contact with the injected fuel droplets the air has a temperature of about 760 degrees centigrade. A spontaneous combustion process is introduced especially by the admixture of carbon disulphide. As a consequence of the multiplicity of injection points, of high injection pressure and the resultant good atomization of the fuel droplets, of the high temperature (760 degrees centigrade), and of the high pressure (68 kg/mm^2) of the combustion air, the combustion is quite complete, in spite of the high air velocity in the combustion chamber (70 m/s) and in spite of the very short combustion duration period (2.5 thousandths of a second). At the end of combustion the gases in the missile have reached a temperature of 1670 degrees centigrade. The combustion gases leave the nozzles at 1700 m/s and develop a thrust of 2280 kilograms. After 20 seconds the combustion is completed; the missile has reached its maximum velocity of 1880 m/s at an altitude of 24 kilometers.

The protection of the interior walls of the combustion chamber against high temperatures is done in the following manner: The wall of the fuel container is greatly cooled by the fuel, which adheres to the wall as a result of centrifugal forces. The flame is directed by the manner of injection in such a way that it does not touch the outer shell(2) until it reaches the end of the combustion chamber. The air streaming past outside removes heat from the outer shell. The great mass of the nozzle (3) is able to absorb heat during the short burning period. Nevertheless, there were instances of bore erosions observed in the nozzle (3); these erosions were of no significance in the function of the missile, however. The most difficult part of the cooling was the effective cooling of the posterior flanges (Stege) (26). This was done by means of borings connected with the fuel container and filled with circulating fuel. All parts exposed to the flame are provided with ceramic insulation.

Rotation gain: During flight the gases drive the diagonal posterior flanges in such a way as to increase rotation so that even at terminal velocity the rotation values necessary for a stable and continuous trajectory have been maintained.

Missile at impact: The missile of this type is provided with a supersensitive impact detonator. The missile nose, fixed at three places, and the rigidly bound striker give enough impetus, even when the missile lands at an angle slightly less than vertical, to the detonator to explode the charge above ground (impact velocity at about 480 m/s).

SECRET/CONTROL - US OFFICIALS ONLY

Putilovo

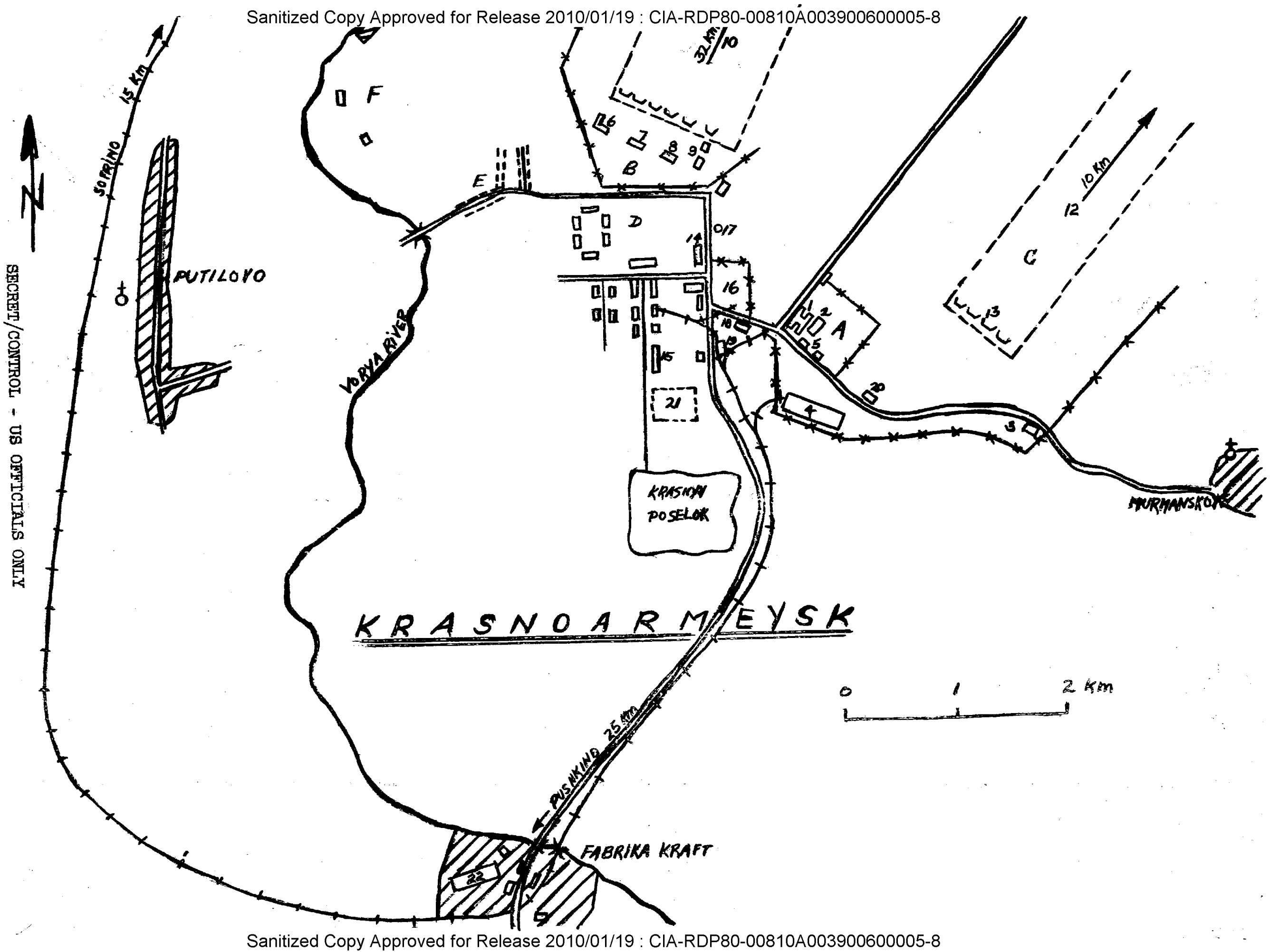
30 June 1945 - 16 June 1952

Project	1947	1948	1949	1950	1951	1952
A-4	Theoretical and construction work on A-4 and C-3 running parallel			Beginning of 1950: A-4 construction finished		
C-3	Theoretical and construction work on A-4 and C-3 running parallel		End of 1949: C-3 construction completed	To end of 1950: Improvements in construction, experimental firings (possibly of C-3 and A-4)		
E-5	Development in the test-missile	Experimental firings Improvements in construction				
10 x 10 cm wind tunnel	Calculations and studies		Tunnel built and used in experiments; Mach 8			
25 x 25 cm wind tunnel			Calculations and working drawings until November	Building of structures observed		
Radial compressor				Theoretical projects and calculations; 29 September lecture Moscow		February: construction completed

SECRET/CONTROL - US OFFICIALS ONLY

25X1

SECRET/CONTROL - US OFFICIALS ONLY



SECRET/CONTROL - US OFFICIALS ONLY

25X1

 25X1

Legend to Sketch of Krasnoarmeysk

A. Design Bureau KB-3.

1. One-story building with all rooms used by the Design Bureau.

2. Laboratory. The laboratory was equipped with brand new German machine tools and had excellent vertical drill presses. 25X1

    a. One planing table, 1 x 2 meters.

    b. 30-40 standard lathes, height of centers 300-500 meters [sic] length of material to be lathed may be up to five meters.

    c. Shaping and ripping machines, cold saws.

    d. Foundry for small bronze castings.

    e. Forges. Cabinet making.

    f. Precision workshop for the repair of ballistics measuring instruments.

    g. A 400 square meter storage area with captured German instruments.

3. A 10 cm wind tunnel.

4. A 25 cm wind tunnel, in early construction stage, 120 meters long and 15 meters high.

5. Two sheds.

Electricity was supplied by Moscow via a 200-kilowatt private transformer.

Another private transformer was installed to power the wind tunnel. In the laboratory, rockets and projectiles up to 1000 kilograms in weight are being produced.

B. Firing range with shops.

6. Powder charging installation.

7. Munitions production.

8 and 9. Outbuildings with shops.

10. Firing range, 32 kilometers long.

11. Six gun emplacements.

C. Rocket practice range

12. Practice range, 19 kilometers long.

13. Four rocket launching emplacements.

D. Firing Range (poligon)

14. Headquarters.

15. Barracks for range personnel, 3 stories.

16. Automobile garage and workshops surrounded by a board fence; individual buildings are not marked.

17. Water tower, 30 meters high, a conspicuous landmark.

18. Bath house.

19. Central heating plant.

20. Sawmill.

21. Athletic field.

The remaining structures indicated but not enumerated in the diagram are residence, administration, and service buildings belonging to the firing range.

E. Colony of German experts. This colony consisted of small plywood houses.

F. Sheds and barns west of the large practice range in the forest.

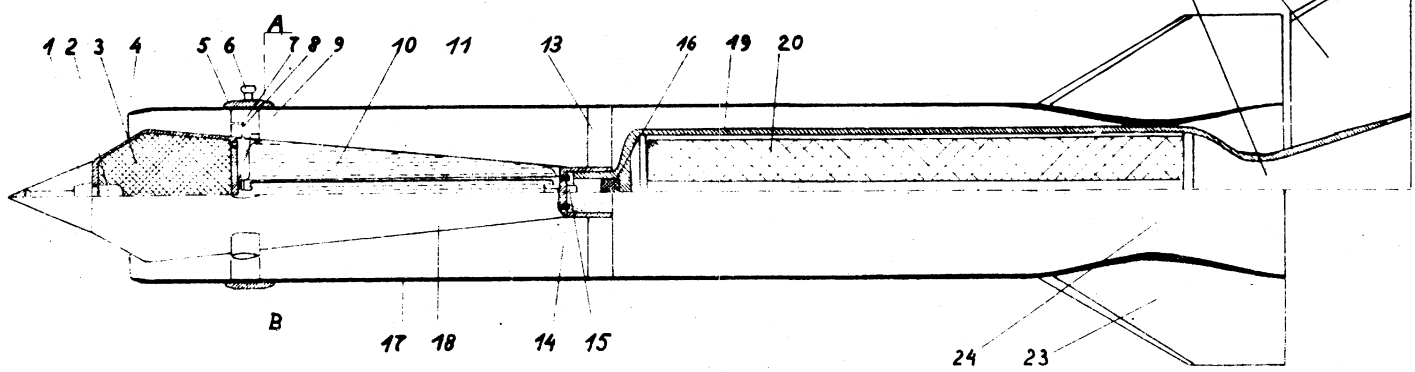
22. Large factory buildings for the manufacture of small consumer articles.

The scale of the sketch is valid for approximate distances but may not be cited for estimating the dimensions of the individual buildings.

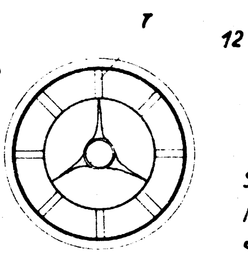
Enclosures:

1. Sketch of Tr. Geschoss A-4, (Tr. Missile A-4).
2. Sketch of the 15 cm Tr. Geschoss (15 cm Tr. Missile).
3. Sketch of the 15 cm Tr. Versuchsgeschoss (15 cm Tr. Experimental Missile).
4. Sketch of the 28 cm Tr. Geschoss (28 cm Tr. Missile, C-3).

Enclosure I



Schnitt A-B



Daten des Geschosses

Sprengstoff	250 kg	Anfangsgeschw	740 $m \cdot s^{-1}$
Mantel	240 "	Höchstgeschw.	1250 $m \cdot s^{-1}$
Stabilisator	20 "	Reichweite	150 km
Sprengstoffbeh:	120 "		
Brennstoff	54 "		
Brennstofftank	66 "		
Geschoss	750 kg		

Abschussrakete:

Pulver 375 kg Kammer 335 kg

Abschussladung 25 kg. zus: 735 kg

Tr Geschoss A_4

Skizze ohne Masstab

1 Zünder	13 Hintere Stege.
2 Zündladung.	14 Zündlunte
3 Sprengladung.	15 Zünder für Ausstoss
4 Diffusorschneide	16 Ausstossladung.
5 Verstärkungsring	17 Mantel
6 Führungswarze.	18 Zentralkörper.
8 Pitotrohr.	19 Pulverraketenkamm
7 Vordere Stege.	20 Raketenpulver
9 Brennstoffdüsen.	21 Pulverraketendüse
10 Brennstoff	22 Pulverraketenstabili
11 Zentralrohr	23 Stabilisierungsfl.
12 Brennstoffsack (leer)	24 Lavaldüse.

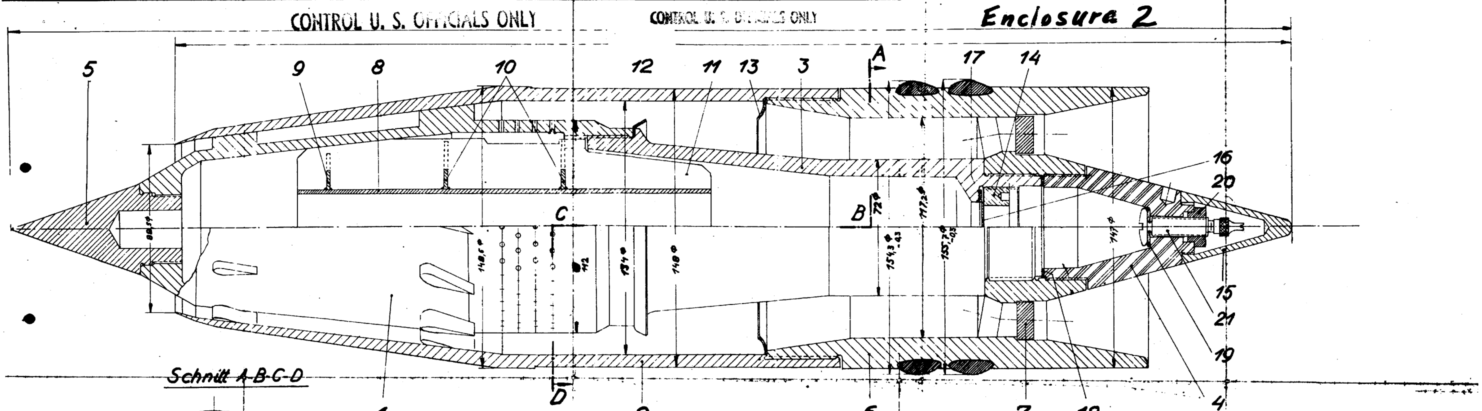
25X1

SECRET

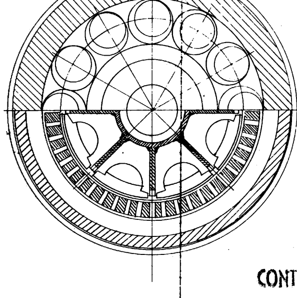
CONTROL U. S. OFFICIALS ONLY

CONTROL U. S. OFFICIALS ONLY

Enclosura 2



Schnitt A-B-C-D



SECRET

CONTROL U. S. OFFICIALS ONLY

SECRET

CONTROL U. S. OFFICIALS ONLY

Stück Zahl	Bennennung	Teil Nr.	Werkstoff	Zeichnungs Nr.	Bemerkung
1	Autoschlauchventil 1/8 5	21	—	—	
1	Mutter 1/8 E	20	St 50.113	Ve-130b-2138	
1	Dichtungsring	19	Gummi	Ve-130b-2137	
1	Dichtungsring	18			
2	Dichtungsring	17			
1	Membran	16	Messing bl. 1,5		
1	Kappe	15	St. 50.11	Ve 130b-2130	
1	Gewindering	14	St. 60.11	Ve-130b-2131	
1	Ring	13	Blech 1 mm dick	Ve-130b-2133	
1	Ring	12	" " "		
8	Schaufeln	11	St. 00.21	Ve-130b-2132 Untergruppe 1	
2	Zwischenring	10	St. 00.21		
1	" "	9	"		
1	Rohr	8	"		
1	Abschlußring	7	EC. 100 verg.	Ve-130b-2136	
1	Düsenring m. Führungsbändern	6	" "	Ve 130b-2135	

Stück Zahl	Benennung	Teil Nr.	Werkstoff	Zeichnungs Nr.	Bemerkung
1	Spitze	5	St 60.11	Ve-130b-2127	
1	Brennstoffbehälter Heckteil	4	St 60.11	Ve-130b-2129	
1	Brennstoffbehälter	3	St 60.11	Ve-130b-2120	
1	Hülse (Vorderteil)	2	St. 60.11	Ve-130b-2126	
1	Brennstoffbehälter	1	St. 60.11	Ve-130b-2125	

1:1

15 cm Tr.-Geschoß

Ausführung Januar 1945

Ve-130b -2134

62

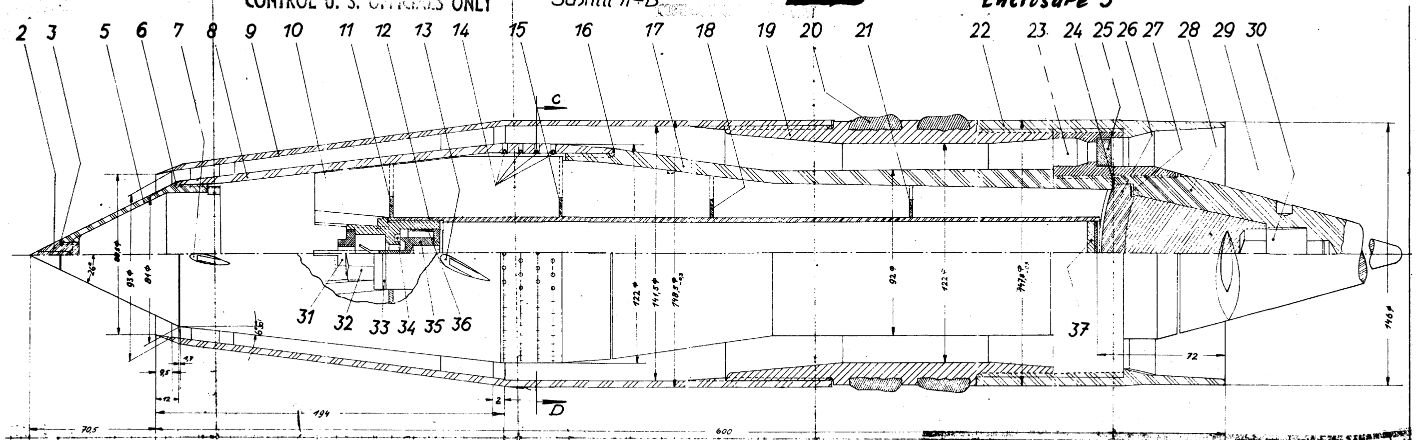
SECRET

CONTROL U. S. OFFICIALS ONLY

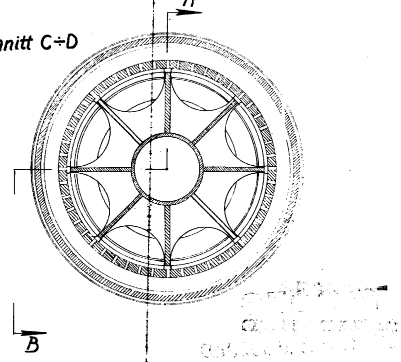
Schnitt A÷B

[redacted]

Enclosure 3



Schnitt C÷D



Stück-zahl	Benennung	Teil	Zeichn. Nr.	Werkstoff
1	Boden f. Torsionsrohr	37	IcFK-1568	St 32.12
1	Ventilkolben	36	" " Dm	St 50.11
1	Dichtungsstössel	35	" " "	St. 50.11
1	Dichtungsring 20×12×3	34	" " "	
1	" " 40φ×36φ×1	33	" " "	
1	Ventilglocke	32	" " "	St 50.11
1	Abschlußdeckel	31	" " "	St 50.11
1	Bodenzünder Bd Z 5121	30	" " B1	
1	Anzeigeladung	29	" "	
1	Ladungsbehälter	28	" " D9	St C60.61 vg.
1	Dichtungsring	27	" " "	Cu
1	Boden f. Ladungsbehälter	26	" " "	St. C60.61 vg.
1	Abschußdeckel	25	" " E10	EC 100
1	Dichtungsring 98φ×71φ×0,8	24	" " D4	Cu
1	Düsenring	23	" " D5	VCMo 135 vg.
1	Hülle (Düsenteil)	22	" " D6	St C60.61. "
1	Stützscheibe	21	" " B11	St 00.21
2	Führungsringe	20	" " B1	ES
1	Hülle (Mittelteil)	19	" " D4	St.
1	Stützscheibe	18	" " B11	St. 00.21
1	Brennstoffbehälterhinterteil	17	" " D2	St C.60.61. vg.
1	Dichtungsring 118φ×112φ×	16	" " B1	Cu
1	Stützscheibe	15	" " B11	St. 00.21
182	Einspritzdüsen	14	" " B1	Cu
12	Verkleidungen	13	" " B1	
1	Torsionsrohr	12	" " B11	St. 35.29
1	Stützscheibe	11	" " B11	St. 00.21

Stück-zahl	Benennung	Teil	Zeichn. Nr.	Werkstoff
8	Torsionsschaufeln	10	IcFK-156 B11	St 00.21
1	Hülle (Vorderteil)	9	" " C8	St. 50
1	Brennstoffbehältervorderteil	8	" " C3	St C 60.61 vg.
6	Verkleidungen	7	" " B1	
1	Dichtungsring	6	" " B1	Cu
1	Geschoßspitze	5	" " D7	St. 50.11
—	—	—	—	—
1	Dichtungsring	3	" " B1	Cu
1	Füllschraube	2	" " D7	St. 37.12
—	—	—	—	—

WaF

Maßstab 1:1

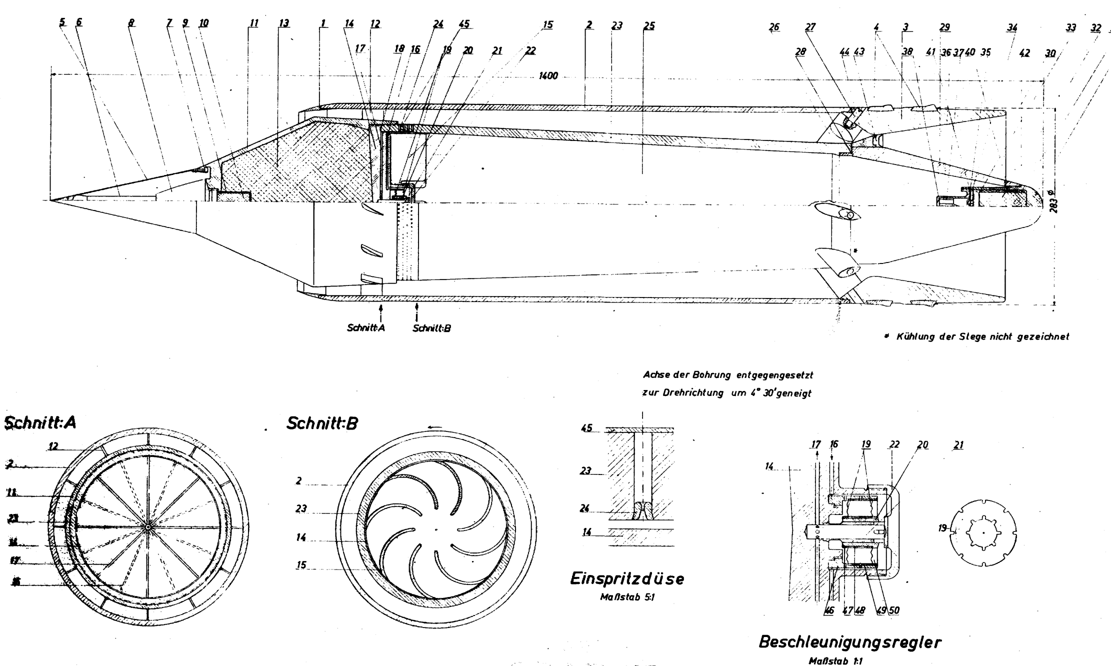
15 cm Tr. - Versuchsgeschoß Ausführung A.

Ic7K-156B1

SECRET

CONTROL U. S. OFFICIALS ONLY

Enclosure 4



Stückzahl	Benennung und Bemerkung	Teil	Zeichng. Nr. Lag. Nr.	Werkstoff u. Rohmaße	[illegible]
1	Abstandsring	50		Stahl	0,003
1	Abstandsring	49		Stahl	0,016
1	Abstandsring	48		Bronze	0,006
1	Abstandsring	47		Bronze	0,001
1	Blattfederhalter	46		Stahl	0,068
1	Verschlußhaut	45		Kollodium	0,005
1	Treibspiegel	44		Stahl	1,612
1	Treibspiegelliderung	43		Kupfer	0,706
1	Dichtungsring	42		Blei	0,006
1	Dichtungsring	41		Blei	0,006
1	Entlüftungsschraube	40		Stahl	0,000
1	Treibkörpermantel	39		Asphalt	0,040
1	Verschlußkappe	38		Stahl	0,162
1	Scherstift	37		Gußeisen	0,000
1	Schlagbolzen	36		Stahl	0,059
1	Übertragungsladung	35		Schwarzpulver	0,002
1	Abdeckplatte	34		Stahl	0,055
1	Beiladung	33		Schwarzpulver	0,012
1	Treibkörper	32		Diglykollpulver	0,118
1	Treibkörperbehälter	31		Stahl	0,631
1	Zündhütchen	30			0,006
1	Heckstück	29		Stahl	10,977
1	Dichtungsring	28		Blei	0,020
8	Haltebolzen	27		Stahl	0,140
8	hintere Stege	26		Stahl	1,030
	Brennstoff	25		Flammöl	16,289
480	Einspritzdüsen	24		Kupfer	0,033
1	Brennstoffbehälter	23		Stahl	40,670
1	Verschlußkappe	22		Stahl	0,120
1	Schlitzrohr	21		Kunststoff	0,003
1	Beschleunigungsregulierg.	20		Bronze	0,017
2	Blattfedern	19		Federstahl	0,007
1	Dichtungsring	18		Blei	0,029
8	Brennstoffkanäle	17			0,000
8	Brennstoffkanäle	16			0,000
8	Umwälzflügel	15		Stahl	0,454
1	Mittelstück	14		Stahl	8,372
1	Sprengladung	13		Tri-Nitrotoluol	9,596
12	vordere Stege	12		Stahl	0,198
1	Sprengstoffbehälter	11		Stahl	11,105
1	Beiladung	10		Tri-Nitrotoluol	0,034
1	Beiladungsbehälter	9		Eisen	0,071
1	Aufschlagzünder	8		Aluminium	0,782
3	Haltenocken	7		Stahl	0,038
1	Stößel	6		Stahl	0,019
1	Geschoß-Spitze	5		Stahl	0,301
2	Führungsringe	4		Sintereisen	3,530
1	Düse	3		Stahl	29,449
1	Mantel	2		Stahl	35,300
1	Diffusorschneide	1		Stahl	0,625

Änderungen

	Datum	Name
Gezeichnet	2.1.1953	
Geprüft		
Norm gepr.		

Maßstab 1:2,5

Tr-Geschoß 28 cm

SECRET

CONTROL U. S. OFFICIALS ONLY